Gradient Alloy for Optical Packaging

Completed Technology Project (2012 - 2012)

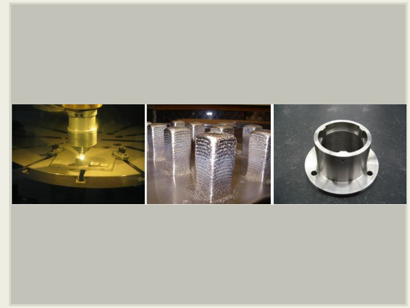
Project Introduction

Advances in additive manufacturing, such as Laser Engineered Net Shaping (LENS), enables the fabrication of compositionally gradient microstructures, i.e. gradient alloys. LENS has been successfully demonstrated for a stainless-steel/Invar gradient alloy for controlled thermal expansion. The objective of the workshop is to determine the best application for stainless-steel/Invar and other metallic gradient alloys. Applications can include optical assemblies and packages and transitional joints.

The proposed workshop is innovative in that it explores the use of additive manufacturing for the fabrication of hardware. Currently, all additive manufacturing techniques are in the early stages of development, both commercially and at other NASA centers. This technology, which includes processes like LENS, e-beam welding, and ultra-sonic additive manufacturing, aims to reduce the need for machining metal parts from large billets by creating net or near-net shapes using only the metal required for the final part. In 2012, JPL R&TD is funding the development of a novel steel-Invar alloy that is included in this proposal as the weld connection between a steel bench and an Invar optical mount. By tuning the composition of the gradient alloy to the prototype hardware, the thermal expansion between the two can be predicted and controlled. This will eliminate the need for brazing or fastening hardware, reduce the stresses associated with thermal-cyclic fatigue, and improve reliability. The fabrication of such a gradient alloy by traditional metallurgical techniques is not possible. The LENS technique offers the additional ability to fabricate net and near-net shape components from the gradient alloy, limiting the need for machining, by laser depositing the constituent metals at independently controlled rates via the LENS system's computer-controlled multi-nozzle feature. The resulting part is fully dense, has a gradient transition from one alloy to another, and is tough (free of cracks and brittle intermetallic phases). The workshop is a natural evolution advancement from the current project because it will utilize the new material in optical packaging and other applications that are plagued with design challenges.

Anticipated Benefits

This work will have a significant impact on JPL/NASA funded missions. Gradient alloys become a viable material option for missions requiring certain properties, such as low thermal expansion. Nearly all JPL/NASA spacecraft and instruments, such as Wide Field Infrared Survey Telescope (WFIRST), contain optical assemblies. These complex assemblies have high-precision requirements which necessitate the use of low CTE materials (e.g. Invar) to support the actual optics (i.e. optics mount).



Project Image Gradient Alloy for Optical Packaging

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Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

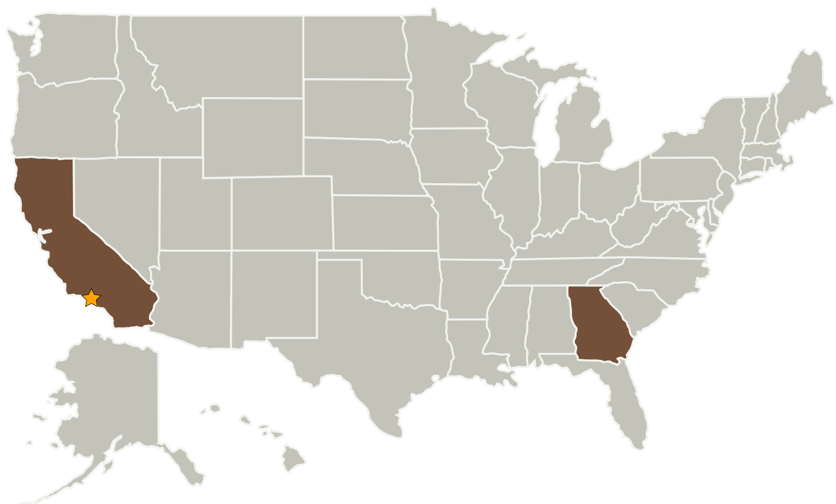
Lead Center / Facility:

Jet Propulsion Laboratory (JPL)

Responsible Program:

Center Innovation Fund: JPL CIF

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Jet Propulsion Laboratory(JPL)	Lead Organization	NASA Center	Pasadena, California

Co-Funding Partners	Type	Location
Georgia Institute of Technology-Main Campus(GA Tech)	Academia	Atlanta, Georgia
RPM and Associates	Industry	
University of Southern California(USC)	Academia	Los Angeles, California

Primary U.S. Work Locations	
California	Georgia

Project Management

Program Director:
Michael R Lapointe

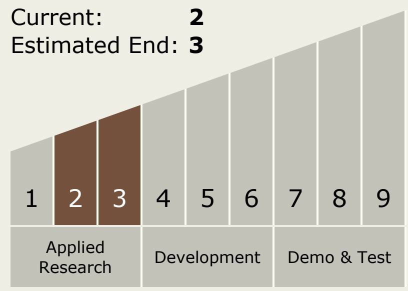
Program Manager:
Fred Y Hadaegh

Project Manager:
Jonas Zmuidzinas

Principal Investigator:
John Borgonia

Technology Maturity (TRL)

Start: **2**
Current: **2**
Estimated End: **3**



Technology Areas

Primary:

- TX03 Aerospace Power and Energy Storage
  - └ TX03.1 Power Generation and Energy Conversion
    - └ TX03.1.5 Electrical Machines

Images

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(https://techport.nasa.gov/image/1177)